AUDIO PLAYER SYSTEM

The present invention relates to a new audio player system for enabling a user to copy digital audio material from an optical storage medium, such as a Compact Disk (CD) or Digital Video/Versatile Disk (DVD), to a portable audio player device having solid state memory.

According to the invention we provide an audio player system comprising: a portable base unit having audio data extraction means for extracting digital audio data from at least one optical storage disk which may be engaged in the base unit in use thereof, non-volatile memory means for storing audio data extracted from said at least one optical storage disk, and data copying and transfer means for copying audio data stored in said memory means and transferring said copied data to an output interface means of the base unit; and a removable audio player device comprising solid state memory means for storing audio data thereon, and playback means for enabling audio data stored in said solid state memory means to be played to a user, said player device having complementary interface means for interfacing with said base unit output interface means whereby audio data may be transferred from the base unit to the solid state memory means of the removable player device.

The invention thus provides a consumer digital audio product using a combination of solid state and magnetic storage. This fusion of technologies allows the creation of a rugged, small and low power player with the capability of extremely rapid download of a large library of music.

The solid state memory means of the player device is preferably DRAM means. Alternatively, the solid state memory means may be FLASH memory means.

The playback means of the player device is preferably formed and arranged for playback of audio data stored in the solid

state memory means both while the device is not interfaced with the base unit and while the device is interfaced with the base unit. The playback means may also be formed and arranged for playback of audio data supplied directly to the playback means from the base unit while the player device is interfaced with the base unit.

The audio data extraction means of the base unit preferably comprises a CD drive, or a CD-ROM or DVD-ROM drive. The non-volatile memory means preferably comprises one or more hard disk(s).The copying and data transfer means preferably comprises processor means, for example a microprocessor, for carrying out and controlling the copying of audio data from the memory means of the base unit, and transferring the copied data to the output interface means. The output interface means is preferably formed and arranged for handling relatively high speed download of data to the removable player device and may for example, be a Compact Flash interface. The base unit preferably also includes data compression means, for example an MPEG Layer III encoder, for compressing the digital audio data read from one or more CDs engaged in the CD drive in use thereof, prior to storing the compressed data in the memory means of the base unit. Compressing the data in this manner has the advantage of enabling very fast downloading rates to be achieved for download of data from the base unit to the player device, for example much faster than real time CD playback rate.

The playback means of the removable player device preferably includes Digital to Analogue (D/A) converter means for converting stored digital data to analogue form suitable for playback to a user via, for example speakers or, more preferably, headphones, which may be attached to an analogue output of the player device. Where the base unit incorporates data compression means for compressing the data which is copied to the base unit memory means from the CD(s), the player device will incorporate data decompression means formed

and arranged for decompressing the compressed data which is downloaded to the solid state memory means of the player device from the base unit. The playback means of the player device preferably includes processor means for controlling operation of the player device and playback of audio data. The interface means of the player device is preferably formed and arranged for receiving data downloaded thereto at at least the same rate as the rate at which data is transferred thereto by the output interface means of the base unit.

The player device preferably further includes selection means for enabling a user to select audio data to be copied to the DRAM means from the base unit. The control means may include user interface means for enabling a user to input, for example, CD or CD track identification data to a non-volatile memory means provided in the player device. The user interface means may include visual display means for displaying information (such as track number) to a user, and/or audio input means, such as a microphone, for enabling a user to input audio identification data to the player device. The processor means of the player device is preferably configured and/or programmed to input the stored, user-entered identification data to the base unit, when the player device is interfaced therewith, and the base unit is configured and/or programmed to use the identification data input thereto to select the tracks to be copied to the player device from the memory means of the base unit.

Where the solid state memory means comprises DRAM means, the player device will preferably further include refresh signal means formed and arranged for refreshing the DRAM means after data has been transferred or "downloaded" thereto from the base unit so that data stored in the DRAM means is maintained therein for at least a predetermined period of time after data has been downloaded thereto. Said predetermined time may, for example, be only a few hours whereby the music copied to the player device is a temporary copy.

The interface means of the player device preferably comprises a standard Compact Flash slot and the output interface means of the base unit comprises a complementary interface formed and arranged for inserting into said slot. The playback means is preferably formed and arranged for enabling the player device to playback data from a standard Compact Flash card which may be inserted into said slot when the player device is not being interfaced to the base unit.

The base unit may be provided with copy controlling means for limiting the number of times that data copied onto the memory means thereof can be copied and transferred to the removable player device. The copy controlling means may be provided in a processor means of the base unit which may, for example, be programmed to prevent data, such as the contents of a CD copied to the memory means, from being copied to the player means more than a predetermined number of times unless the original data source (e.g. the original CD) is reinserted into the base unit. Alternatively, the processor means may be programmed to prevent the same CD from being copied to the player device again until a predetermined time has passed from it last being copied (e.g. one week).In this case the base unit would include suitable timer means for enabling said predetermined time to be measured.

In one possible embodiment, a playback time credit may be stored in a non-volatile memory in the base unit, said playback time credit being an allowed amount of playback time (in the player device) of audio data which has been copied to the memory means of the base unit. In this embodiment, the player device is preferably provided with a non-volatile memory and is configured so as to log in this non-volatile memory the amount of playback time used in the player device (since a given starting time). The base unit is preferably configured to subtract from the stored playback time credit in the base unit the playback time logged in the non-volatile memory of the player unit, when the player unit is interfaced

into the base unit. The base unit is preferably also configured so as to request a CD validation process to be carried out by the user when the playback time credit stored in the base unit reaches a predetermined minimum value, and to prevent further use of the base unit until the validation process has been carried out correctly.

Preferred embodiments of the invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Fig.1 shows a portable audio system according to the invention;

Fig.2 shows a base unit of the audio system of Fig.1;

Fig.3 is a rear perspective view of a removable player device of the audio system of Fig.1;

Fig.4 is a front perspective view of the player device of Fig.3;

Fig.5 is a block diagram of the various components of the player device of Figs. 3 and 4; and

Fig.6 is a block diagram of the various components of the base unit of Fig. 2.

The portable audio system of Fig.1 comprises a base unit 1 and a removable player device 2. The player unit 2 and base unit 1 plug together via complementary interfaces 3,4 to facilitate the download of music from the base unit to the player. The detached player 2 is very small and lightweight and incorporates storage means which is entirely solid state. In the described embodiment this solid state storage means is DRAM. DRAM offers several advantages which will be described, but alternatively, as described further hereinbelow, FLASH memory may be used in the player 2 instead of DRAM. The player 2 does not incorporate any magnetic tapes, optical disks, or any mechanical drives therefor. The player is powered by one or more internal (replaceable) batteries. A set of standard headphones (not shown) may be plugged into a standard jack socket 5 provided on the player 2. Alternatively, a cassette

adapter for use with a standard cassette unit in a car may be plugged into the jack socket 5. The player 2 is smaller than an audio cassette and may be easily carried in a pocket. It is especially suitable for use while exercising where its solid state nature avoids the problem of music tracks "skipping" or jumping as often occurs in conventional portable CD players due to mechanical vibrations exerted thereon.

The base unit 1 is shown in further detail in Fig.2, and Fig.6 illustrates in block diagram the various components of the unit. The base unit 1 is approximately the size of a standard portable CD player, although a little thicker. It incorporates a CD interface 20 consisting of a CD drive mechanism (comprising a CD drive and associated interfacing electronics for interfacing to other electronics in the player 2) for extracting audio data from a CD 6 which may be inserted thereinto, an integral hard disk unit 22 (comprising one or more hard disks) for magnetic storage of music, and a Compact Flash interface 3, of "male" type, for interconnecting with a complementary Compact Flash interface 4 of "female" type provided in the player unit 2. The base unit 1 is powered from an internal rechargeable battery (not shown). The hard disk unit 22 provides capacity for approximately 50 average length CDs. Copies of new CDs may be added to the collection on the hard disk by playing them in the CD drive mechanism integrated into the base unit. It will be appreciated that the base unit provides permanent storage for CDs that have been played in the CD player. The base unit is not able to play music directly, its function is as a copying device for allowing a user to add a new CD to their collection stored in the hard disk(s) 22 inside the unit.

The player 2 is a small portable unit that may be detached from the base unit, as shown in Fig 1. The player unit 2 is shown in further detail in Figs.2 and 3, and Fig.5 is a block diagram showing the various components thereof. Its approximate dimensions are length (A) 80mm x breadth (B) 60mm X thickness (C) 20mm. This is somewhat smaller than a

conventional magnetic tape cassette. The player 2 has 64MBytes of internal DRAM 10 that is used to store audio data downloaded from the base unit 1. Since DRAM is dynamic it needs to be constantly refreshed to maintain its content. The player incorporates a microprocessor 12, powered by one or more internal batteries (not shown), which controls refreshing of the DRAM. In the described embodiment, the microprocessor issues a refresh signal (either of continuous or pulsed form) to the DRAM while the player 2 is being used (for playback). When the player is not being used the DRAM does not receive this refresh signal and so data stored thereon will be lost. (Alternatively, the player unit may continue to issue the refresh signal to the DRAM for a predetrmined period of time after the player has stopped being used for playback, thus retaining the stored music in the DRAM for at least a preset time period.) Other embodiments are possible in which different types of DRAM refresh techniques are used. For example, the player microprocessor may be programmed to set the DRAM in a mode in which it refreshes itself (using power from the player unit batteries), while the player is being used and also for at least a predetermined period of time during which the player is not being used. This enables the music stored in the DRAM to again remain in the DRAM (for later use) for a preset period of time during which the player is not being used (for playback of music), but reduces the power requirement in the player (when it is not being used) and thus enables the player batteries to last longer.

The intention with the system is that music will be listened to immediately after being downloaded from the permanent storage (hard disk unit 22) in the base unit 1. If the player unit 2 is left unused the refresh to the DRAM is stopped and the audio data stored thereon will (immediately, or after a minimal period of time) be lost.

The player unit 2 has standard personal stereo controls 14 on a front face 16 of the unit, these controls including volume,

stop, play, pause and track skip etc. Additional controls 18 are also provided on the player 2 for CD selection and music collection editing. A LCD display 19 is used to display status information such as the current track number.

Unwanted CDs may be deleted from the hard disk to make room for new additions. This is achieved by means of a microprocessor 12 incorporated in the player 2, to which user instructions (e.g. delete stored data) may be entered via the control buttons 18 in the player 2. The base unit microprocessor 24 is programmed to receive such user instructions from the player 2 and to effect and control deletion of material from the hard disk in response thereto.

The base unit 1 further included data compression means in the form of at least one MPEG encoder 28 for compressing digital audio data read from the CD 6, prior to the compressed data being stored on the hard disk(s) 22. The compression thus occurs when a new CD is committed to storage in the base unit. Such data compression is used in order to maximize the duration of audio data that may be stored in the 64MB of DRAM in the removable player unit 2. The MPEG encoder 28 preferably uses MPEG-2 Layer III compression which allows an approximate 12 to 1 compression ratio of audio while maintaining near CD stereo quality. Given that a CD of average length has approximately 500MB of uncompressed data on it, the average CD should therefore be compressed down to 42MB by the encoder 28. The hard disk unit 22 contains a 2.1GB hard disk which thus provides storage capacity for the music recorded on 50 CDs.

The base unit of Figs.1 and 2 is slightly larger than a standard portable CD player. It has dimensions as follows: length (X) 140mm x breadth (Y) 140mm x thickness (Z) 30mm. The base unit requires only a very minimal user interface 26, in the present case just a copy button, a stop button and an eject button. A small LCD display 27 may also be provided to show the amount of time remaining before CD copying is

complete. (Instead of this LCD display, other indicator means e.g. an LED may be used to indicate when copying is complete.) When a new CD is inserted into the unit and the copy button of the user interface 26 is pressed, the content of the CD is then compressed by the encoder 28, using MPEG-2 layer III encoding, and transferred, via an IDE interface 30 in the base unit, to the hard disk unit 22 for permanent storage thereon. Since this operation only needs to be performed once for each CD, it only needs to occur at a rate at or below the real time playback of the CD. Once the copying is complete the CD 6 may be removed from the base unit 1. The contents of the CD may then be downloaded in less than 10 seconds to the player unit 2. The base unit is configured to receive control signals from the player unit 2 (when it is interfaced thereto) which can be entered by a user, using the control buttons 14,18 on the player 2, to delete CDs or individual tracks stored on the hard disk 22 to make room on the hard disk if it fills up. The base unit includes an ATA card interface 32 for interfacing the microprocessor 24 and the Compact Flash interface 3 of the base unit 1, thereby enabling the microprocessor 24 to receive control signals from the player unit 2 when it is connected to the base unit 1. The player unit 2 includes its own ATA host interface 9 operative between the player unit microprocessor 12 and the Compact Flash interface 4 of the player, for enabling control signals and commands to be passed from the player unit 2 to the base station 1 and vice versa.

Use of DRAM to store music downloaded to the player 2 means that music copies held on the player are intrinsically temporary. If the unit is left unused for any length of time then refresh to the DRAM is as above-described disabled in order to conserve battery power. The 64MB DRAM provides enough storage space for up to approximately 90 minutes of music, enough to hold the full contents of the longest possible CD. When audio data is copied from the hard disk unit 22 of the base unit, to the DRAM 10 of the player unit 2, it is transferred in the compressed from in which it is stored in

the hard disk(s)of the base unit 1. The player 2 includes an MPEG audio decoder 11 for decompressing the data downloaded from the base unit. This decoder 11 is connected to a D/A converter 21 for converting the decompressed digital data to analogue output which is sent to the output (jack socket 5) of the player unit 2.

When the player 2 is attached to the base unit, the Compact Flash interface slot 4 can be used for plugging a standard compact flash card 15 thereinto to allow playback of music stored on the flash card, as illustrated in Fig.3. Such music may, for example, have been downloaded from the Internet or a set top box via which music has been purchased from a cable or satellite supplier. Alternatively, the flash card may contain music which has been transferred thereto from a vending facility such as a music vending kiosk. A flash card may also be used to provide extended battery life when the unit is left unused by allowing audio data stored in the DRAM 10 to be held in non-volatile flash (by copying it to the flash card) rather then kept in the DRAM. The base unit may also be configured to allow music tracks to be uploaded to the hard disk 22 thereof from the player 2. This function would be advantageous where music can purchased directly on a compact flash card, or downloaded to a FLASH card via a music vending machine or set-top box, since this would enable the purchased music to be stored in the hard disk 22 of the base unit, if desired.

The playback of audio data stored on the hard disk unit 22, using the player unit 2, will now be described in detail. The selection of a new CD to be listened to is made on the player 2 using an audio indexing system (described in further detail below). The player device includes non-volatile memory 17, in the present embodiment this is 2Mbytes of FLASH memory, for storing audio index information. Once selection is complete the player 2 may be connected to the base unit 1 and the requested CD, or requested tracks, is/are automatically transferred in less than 10 seconds. The player 2 may then be

detached and is ready for playback. The player controls 14,18 include user controls for track skipping, rewind and fast forward.

In comparison to a standard personal CD player, the player unit 2 of the present system is advantageous in that its operation is quicker and less cumbersome than a standard CD player in which the selection of a new CD from a storage wallet, and its exchange for the CD in the player, is required. The space occupied by the player and base unit is much less than the requirements for carrying a portable CD player and the assortment of CDs required by current portable CD players. This is especially convenient if the player is to be used on a long journey where less space is used and the CDs themselves do not need to be carried. A collection of 50 CDs would normally require several quite bulky carrying wallets. Given that a collection of 50 CDs is more valuable than the player this also helps reduce risks of loss of damage.

The player may also be operated while still inserted into the base unit (i.e. not just when it is detached therefrom). This configuration is particularly useful for in-car use where the small size of the overall system is less crucial than the ability to change CD without having to juggle with individual CDs. In this mode the system can act as a jukebox, allowing continuous random play across tracks from the whole collection stored on the hard disk unit 22 of the base unit 1. Tracks to be played back will preferably first be downloaded to the DRAM 10 in the player 2 prior to playback. This allows the base unit to be switched off, to conserve power, after the desired tracks have been downloaded to the player 2. Alternatively, though, tracks may be accessed directly from the hard disk unit 22 by the player 2 and played back directly. In this case, the tracks are delivered directly from the base unit 1 to the decoder 11 of the player, via the player microprocessor 12, as indicated by broken line 35 in Fig.5. The whole unit may be removed from the car when it is unattended. The fact

that the whole unit can easily be removed from the car and carried is also a useful anti-theft feature.

The CD selection and music editing controls 18 provided on the player unit 2 include controls to allow the user to make selections for downloads from the base unit 1, controls to add audio indexes to CDs available from the base unit, and storage management controls to delete individual tracks or CDs from the base unit as will be described.

(i) Download Selection

As well as providing the normal playback functions, the player must also provide a mechanism to allow the user to select which CD (or music tracks) they wish to listen to next. Once the selection has been made the player unit 2 may be plugged into the base unit 1 and data transfer is initiated automatically. This operation is the equivalent of selecting a new CD to listen to in a standard portable CD or MiniDisc player. However, the whole operation is much quicker as there is no requirement to remove the old CD, replace it in a protective cover of some description, leaf through other CDs to make a new selection and then put it into the player. In effect, the base unit becomes the equivalent of the CD wallet holding a collection of CDs.

(ii) Audio Index

To avoid the requirement for complex controls to select a new CD a simple audio indexing system is used. Each CD will have a short audio index of a couple of seconds associated with it. This is stored in the non-volatile memory 17 in the player 2 so that it is available even after the refresh has been stopped to the DRAM 10. Only a small amount of non-volatile memory 17 is required as the maximum storage requirement is a couple of minutes of audio (for up to 50 CDs) and a lower sampling rate can be used as the audio quality is of less importance. The audio index entries can come from a number of potential sources, for example the audio index can be recorded from the CD itself. For instance, a chorus line from a track could be used to identify the CD. A capture mode selectable on

the player allows a button to be pressed when the CD is playing to capture the last couple of seconds of playback and make that the index associated with the CD.

The player contains a small microphone 13 that allows the user to alternatively record his or her own audio index for a new CD. For instance, the name of the CD can be spoken by the user and recorded as the audio index. (If a new CD is obtained via a compact flash card then the audio indexes may be provided in the FLASH card, included in the card at manufacture thereof.)

The player controls 18 for CD selection include index access controls to allow the user to select the CD to be downloaded. These are in the form of back and forward buttons 18a,18b to traverse the audio indexes (by listening to them being played back) for the available CDs. When the correct entry is found a selection button 18c can be pressed. To speed up the selection process, the index playback will skip over multiple entries at once if the selection direction buttons 18a,18b are held down. The user may organise the audio index in any way they choose but for easy selection an alphabetical order could be used.

Random Play

The player features a random play function in similar fashion to known portable CD players. However, as well as allowing random play of tracks available on the player it will also allow random selection of new tracks from the hard disk in the base unit 1 when the player is connected thereto for data download. In this mode a new selection of tracks to fill the capacity of DRAM 10 in the player is extracted each time it is plugged into the base unit. Information would be stored in the non-volatile memory 17 of the player (by the microprocessor 11 of the player) identifying which tracks have been recently selected so that they would not selected again the next time music is downloaded to the player 2. In this mode, with the player permanently attached to the base unit, continuous random play across all CDs is possible without any interaction

from the user. This would also allow the system to be used in the home as a digital jukebox (with the output going to a Hi-fi amplifier) or in a car (with the output going to a standard car stereo unit via a cassette adapter).

Most of the controls for the product are available on the player unit where the user may easily access them. A LCD display is used to give the current state of selections or the current track position or time when the device is actively playing music. It may also give other status information such as whether random play mode is selected or not.

Storage Management

The player controls 18 include controls to manage the storage space (hard disk 22) in the base unit 1. One obvious function that is required is a CD delete option. This allows an entire CD to be deleted from the hard disk 22 to make room for new CDs to be added. If a new CD is put in the base unit and there is insufficient space to store it there in compressed form, the microprocessor 24 of the base unit is programmed to issue and error message which is displayed on an LCD (not shown) on the base unit 1. The user must then use the player unit 2 to select a CD to be deleted. The microprocessor 11 of the player 2 is programmed to enable these delete commands to be input to the player 2 by the user (via the user control buttons 18) while the player is separated from the base unit. These commands will then take affect the next time the player 2 is plugged into the base unit 1.

Copy Management

Without any copy management the above-described audio system could be easily used for music piracy. Music on CD could be borrowed from the owner and a permanent digital copy made on the hard disk in the base unit. The original CD could be returned to the owner and the digital copy kept and played at any time. Copy management is therefore critical and is likely to be required by the music industry. Copy management

mechanisms increase the difficulty of making permanent illegal copies of music.

Since the player unit 2 has no digital output facility there is no potential for making second generation copies of music using the device. Data passed from the base unit 1 to the player can also be encrypted so that direct eavesdropping of the communication cannot easily allow access to the music data. Our system is additionally provided with copy management features which are targeted at ensuring that the first generation copy onto the hard disk storage 22 of the base unit is acceptable to the music industry.

A number of different approaches can be taken to implement copy management on the device, depending upon the original source of the music. Where the music is source from standard CDs, one problem with copies made from CDs, using the base unit 1, is that there is no way of determining if the user is the actual owner of the CD. If not, then the copy made on the hard disk is certainly illegal and would be unacceptable to the music industry. Since it is not possible to determine ownership of the CD the next best thing is to determine that the user has consistent access to the CD. If the user cannot prove that the CD is still in his or her possession then the assumption is that the copy was illegal and the copy on the hard disk is made unavailable for download to the player unit 2. In effect this mechanism makes the copy on the hard disk temporary rather than permanent. However, when the user has to present the CD to enable the copy management mechanism there is no need to completely re-copy and compress the data from the CD onto the hard disk again. If the CD can be recognised as the original then the existing data on the hard disk is reused. In effect, the presentation of the CD enables use of the copy. A simple unique attribute of the CD can be used to prove its identity. Either an existing electronic serial number on the CD or the Table of Contents (TOC) can be used to identify the CD. It is highly unlikely that two CDs would have

exactly the same number of tracks of the same length. A read of the CD TOC and re-enable of the data on the hard disk would only take a few seconds.

We propose two different techniques which may be used to limit the use of a hard disk copy before the original has to be presented. Our system is configured to implement either one or the other of these two techniques which are referred to hereinbelow as the "Play Limited" and the "Time Limited" techniques.

Play Limited

In this embodiment of the invention, the number of times that a copy of a CD (stored in the hard disk unit 22) can be played is limited. Once the play limit has been reached the original CD has to be put into the base unit 1 to re-enable the hard disk copy. Until this is done this CD is temporarily flagged (by the base unit microprocessor 24) as not accessible for download to the player 2, and the stored audio index for this CD is made unavailable for selection. It will be appreciated that to implement this embodiment, the base unit 1 will include a counter 34, linked to the microprocessor 24, for counting the number of downloads of any one CD stored in the hard disk unit 22 and activating the microprocessor, when the predetermined maximum count has been reached, to prevent further downloads until the original CD is reinserted in the base unit and a unique identification code thereon is recognised (by the microprocessor 24).

In the extreme, for example, the play limit could be set at one. Thus the CD would have to be presented every time the CD copy is downloaded to the player. This wouldn't add much to the download time of 10 seconds since the CD can be validated in a few seconds. This would increase the user effort involved in downloading a new CD and would mean that the CD has to be carried along with the base unit in order to listen to it multiple times. Even with this quite severe restriction the

unit would, though, still be useable. For instance, a user could quickly put their CDs through the unit before departing on a journey or holiday and leave the original CDs at home. Each of the 50 CDs on the hard disk collection could then be listened to once. This represents a play back time of over 48 hours. If there are particular favourite CDs that the owner wants to listen to several times then just those CDs need to be carried. If the music industry was agreeable then a higher play back limit could be used. The point is that this mechanism prevents permanent copies of music being made without access to the original CD.

Time Limited

In this alternative embodiment time limiting is used to restrict CD copying. In this embodiment, a CD can be downloaded any number of times but there is a time limit from the last time the CD was presented for download to the player 2 (from the hard disk unit 22), after which further downloads are not possible. For instance, it is possible that the time out limit could be set at one week. Once the CD is copied to the hard disk unit 22 for the first time, or re-presented to enable copying again, the timer is initiated. Access to the copied CD (for download) is allowed until a period of one week has passed, after which the CD has to be presented again to the base unit 1 to allow further downloads to the player 2. This mechanism directly enforces a temporary nature to the copies on the hard disk. In order to implement this embodiment it will be appreciated that the base unit will include timer means 34, for example in the form of known clock/counter arrangements, for timing the set period in which access is allowed to the copied CD and for activating the microprocessor 24 to prevent further downloads being allowed until the original CD is reinserted into the base unit 1. Upon detecting the presence of the reinserted CD (by recognising a unique identifying code thereon e.g. ISRC number) the microprocessor again allows downloads of the stored CD to the player until

the set period of time (measured by the clock/counter) has again expired, and the process needs to be repeated again.

It will be appreciated that the primary motivation for the use of a combination of DRAM in the player 2 and magnetic storage in the base unit 1 is that of cost. Current DRAM prices are of the order of $1 per MB whereas cost for magnetic storage on a 2.5" hard drive is of the order of $0.05 per MB. This huge pricing differential makes the concept of using a hard drive for permanent storage of music and DRAM for temporary storage very attractive. Given that the solid state player can be detached from the base unit the advantages of solid state in terms of size and robustness for the player are achieved with the above-described audio system. Due to the nature of the product, the player storage is intrinsically temporary, which is attractive in that the system therefore does not lend itself to the purpose of making permanent unauthorised copies of music e.g. pirate copies.

DRAM is also more attractive than Flash memory for the temporary audio storage in the player unit 2 since the DRAM provides a much higher write bandwidth. To allow the download of a complete CD in less than 10 seconds a data transfer rate of 5MB/s needs to be sustained between the base unit and player. This is relatively easy to achieve using DRAM technology but would require fully interleaved access to multiple NAND/AND flash devices which is beyond the current sustained write performance of existing compact flash cards.

Nevertheless FLASH memory could be used in the player 2 as an alternative to DRAM while still providing some of the advantages of the above-described system. In particular the advantages of solid state in terms of size and robustness for the player are still achieved. Additionally, although the music copied to the player is of a more permanent nature than music copied to DRAM which must be continually refreshed in order to retain its content), the copy management features

provided in the base unit and player (i.e. Time Limited and/or Play Limited versions as above-described) are still an effective measure in controlling to control the use of the base station for mass copying of CDs.

It will be appreciated that various other modifications to the above-described embodiment(s) are possible without departing from the scope of the invention. For example, other variants of random play mode are also possible. A facility, which could be conveniently implemented by appropriate programming of the microprocessor of the player and/or the base unit, could be included to link CDs by the same artist. This would be done when a new CD is added to the collection, by selecting an existing CD by the same artist using a special selection mode. A random play mode could then be selected that only played tracks by the same artist but across multiple CDs. A further variant would allow CDs (stored in the hard disk unit 22) to be assigned to particular mood categories when they are added to the collection. Random play could then be restricted to CDs assigned to the same mood. This would also allow different users with differing musical tastes to share the same product and to partition their music separately from other users.

Further delete options may be provided in the player 2 and/or unit 1 for allowing a user to delete individual tracks stored on the hard disk unit 22 if the he/she doesn't like them. the system may also be configured so that the user can choose that certain tracks are combined so that they are always heard back to back, even if the random play function is selected.

The base unit may of course be of different shape and dimensions to the above-described embodiment. It will be appreciated though that the base unit shape and dimensions will always be such that the unit is of portable, easily transportable form. The base unit may further be formed and arranged for receiving more than one CD at any one time and for extracting audio data from each CD, as requested by a

user. The base unit may further be provided with user interface means/control buttons for enabling a user to instruct the base unit directly to delete data from the hard disk unit 22. This may be in addition to, or instead of, delete controls provided on the player 2.

Other sizes of DRAM in the player are of course possible, not just 64MBytes. The size of DRAM chosen will generally depend on the compression rate used in the base unit, and the desired maximum storage capability of the player 2.

Other indexing systems may be used other than the above-described audio indexing. For example, the player 2 may be provided with index input means, for example a small keypad, for entering index numbers manually. Further possibilities would include the base unit being configured to read off indexes (audio indexes, or other indexes) from a dedicated CD which contains unique indexes for various CDs or CD tracks, or even to obtain indexes for CDs or CD tracks from another available source, for example by downloading index data from an available Internet web site.

The player 2 may further include data copying and transfer means formed and arranged for copying data from the player device and transferring it to the base unit 1, via the player's interface 4. In this case, since it would then be possible for a user to copy original music purchased on FLASH memory (e.g. from a vending kiosk, or via downloading from the Internet) to the hard disk unit 22 of the base station and, from there, on to one or more other similar players 2, the base unit 1 and/or player 2 may be provided with further copy management means in the form of recognition means for recognising authorised and unauthorised copies of music which a user attempts to upload from the player 2 to the base unit 1 and to prevent unauthorised copies from being uploaded. This may be achieved by, for example, programming the base unit to recognise a unique identification code associated with an

authorised copy of music, for example an identification code stored in a FLASH memory card (by the manufacturer/distributor) identifying the music stored on the card as an authorised (e.g. purchased) copy, and/or a unique code which is transferred to the player together with music downloaded thereto from the said base unit. Thus, if a user tries to upload music to a first base unit which has been copied to the player using a second base unit, the first base unit will recognise that this is an unauthorised copy and will prevent it from being uploaded to the first base unit.

It would be possible for both the above-described Time Limited, and Play Limited copy management techniques to be provided in the same audio system, if desired.

Modified Play Limited Embodiment

A modified version of the above-described Play Limited copy management techniques will now be described. As above-described, in the Play Limited system the original CD has to be presented after a certain number of plays in order to enable further use of the copy stored in the base unit 1. One disadvantage of this system is that if the number of plays before validation is quite low then it may represent an inconvenience for the user. If the user wishes to play the same CD many times then the original CD has to be carried in order to re-validate it as required. The modified system now described uses a more statistical approach for validation of CDs. In effect it samples the user's CD collection to determine whether the user has possession of the original CDs. If the user does not have the CD then that is an indication that it may be illegally copied. In this approach the failure to present a particular CD not only prevents the copy of that CD being subsequently used but may also invalidate other CDs on the basis that the collection contains illegal copies. Conversely, a correctly presented CD not only allows the user to continue using the copy of that CD but also allows continued use of other CDs on the basis that the sampling

indicates that the collection is composed of legal copies.

The scheme is based on a fixed playback time credit store in non-volatile memory in the base unit 1. This is the amount of time that copies of CDs may be played before the base unit will request a validation. The player unit 2 logs the total amount of playing time in a non-volatile memory in the player so if a particular album is downloaded and played several times then that is logged. A commensurate reduction from the playback time credit is made each time the player unit 2 is plugged into the base unit 1. Note that the time does not include use of music recorded via a PC interface and not directly obtained from the CD drive (in the CD interface 20) of the base unit 1. When the playback time credit reaches 0 the user is asked to perform a CD validation. The unit will not allow any playback of material copied from any CD until the validation is successfully completed. The initial amount of playback time may be determined by the music industry, but a time of approximately 100 hours is conjectured. Thus the unit can be used without restriction for 100 hours. For instance, this allows the user to make use of the portable audio system (i.e. base unit 1 and player 2) for a long holiday or journey without the requirement to take any physical CDs.

Successfully presenting a CD for validation is termed a recharge operation. The base unit 1 remembers all the CDs that have been played, and the time that they have been played for, since the last recharge operation. If a compilation from many CDs is played then each of the source CDs is deemed to have been played for the duration of the tracks used from that CD. The user may request a recharge operation at any time using a menu option provided therefor on the base unit 1. If successful, this recharges the playback time credit to the maximum value. The user might, for example, wish to do this just before taking the audio system on a holiday or journey. When there is an explicit recharge or the credit reaches 0 the

base unit 1 will ask for a CD to be presented on the CD drive of the base unit. The CD selected will be a random selection from the set of CDs played since the last recharge operation. The random function may be biased so that CDs that have been played more frequently are more likely to be selected. The base unit will ask for a particular CD by displaying the name, or another distinguishing code or label, of the CD on a display provided on the base unit and the user should then present the original CD on the CD drive. The base unit 1 will read the CD to validate that it is the correct one. This may be done by any suitable technique for uniquely identifying the CD, for example by reading a distinguishing code or number from the CD. For instance, the base unit 1 might use the ISRC, or a hashing function of the CD TOC, to uniquely identify the CD. If the correct CD is presented then the playback credit time is reset to the maximum value. If the user cannot find the CD then there is an option to try again. The CD that could not presented will be disabled from further use. Another CD from the set of those played since the last recharge will be chosen and the operation is repeated. The number of validation attempts allowed is likely to be determined by the music industry, but a value of 3 is conjectured. If all attempts fail then all CD copies on the base unit 1 are disabled and the playback time credit is set to the maximum value. Thus to subsequently use any copies on the base unit 1 the original CD must be presented. This effectively removes all illegal copies from the base unit for which original CDs are not available.

The user may validate a CD at any time using an option on the base unit menu. The process is as follows. The CD is placed on the CD drive. If the CD is recognized and its use had been disabled then further use of the disk is enabled, assuming that enough playback time credit is available. An explicit CD validation request has no effect on the playback time credit.

A further extension to the above-described scheme is proposed which makes it even more difficult to use illegal copies of

CDs. One disadvantage of the scheme previously described is that it is still possible to use illegal copies as long as the number used between recharge operations is limited to less than the allowed number of validation retries. In this way the user will always be able to present a CD that they possess to enable the recharge even though the illegally copied CDs will be disabled and will no longer be available. The following extended scheme makes use of the device in this manner less easy. A variable recharged playback credit time is used. This is the value that the playback credit time is set to upon completion of a successful recharge operation. Initially this will be a value like 100 hours. If the first CD requested for validation cannot be presented then the recharge value will be reduced, perhaps halved. If the second choice cannot be presented either then it will be reduced again. Thus a user who cannot consistently present CDs when asked will be granted less playback credit. If the first CD requested is presented correctly on a number of successive occasions then the recharge playback time will be set back to its initial value.